IN THE CLAIMS

The following listing of the claims is provided in accordance with 37 C.F.R. §1.121.

1. (Original) A method for automatically controlling ramp-up of a superconducting magnet, comprising:

connecting a power supply to the magnet;

determining constraining parameters of the ramp-up;

applying power to the magnet;

automatically controlling the ramp-up based on the constraining parameters; and

continuing ramp-up until a predetermined value of a target parameter is reached.

2. (Original) The method of claim 1, comprising automatically controlling a rate of supply current to the magnet based on the constraining parameters, and wherein the target parameter comprises magnet frequency or field strength, and the constraining parameters include magnet current and magnet temperature.

3. (Original) The method of claim 2, comprising:

measuring operating values of the constraining parameters; and

comparing the operating values with set points of the constraining parameters to control the rate of supply current.

4. (Original) The method of claim 2, comprising:

measuring magnet temperature, current applied to the magnet, and magnet field strength continuously during the ramp-up process.

5. (Original) The method of claim 4, wherein constraining parameters comprise magnet current during a first phase of the ramp-up and comprise magnet frequency or field strength during a second phase of the ramp-up.

6. (Original) The method of claim 5, wherein constraining parameters during the first phase and second phase comprise magnet temperature.

7. (Original) The method of claim 6, wherein magnet temperature comprises magnet coil temperature, cryogen temperature, or radiation shield temperature, such magnet temperature controlled to remain less than about 7 K, and a total increase in magnet temperature over the ramp-up is controlled to remain at less than about 2 K.

8. (Original) The method of claim 6, comprising controlling the rate of supply current in the range of 0 to 4 amperes per minute.

9. (Original) The method of claim 5, wherein a switching point specifies when constraining parameters change between the first phase and second phase.

10. (Original) The method of claim 9, wherein the switching point is reached when a field strength of the magnet system becomes stable.

11. (Original) The method of claim 9, wherein the switching point comprises a magnet current in the range of 35-40 amperes.

12 (Original) The method of claim 2, wherein the predetermined value of the target parameter is a magnet frequency of about 15.0002 megahertz.

13. (Original) A method for automatically controlling a ramp-up of a superconducting magnet, comprising:

applying power to the magnet constrained by a target current ramp-up rate and magnet temperature during a first phase of ramp-up;

applying power to the magnet constrained by a target magnetic field strength or frequency and by magnet temperature during a second phase of ramp-up; and

terminating application of power to the magnet upon reaching a target magnetic field strength or frequency.

14. (Original) The method of claim 13, comprising measuring magnet temperature, current applied to the magnet, and magnetic field strength continuously during ramp-up.

15. (Original) The method of claim 13, comprising automatically controlling ramp-up such that the magnet temperature does not exceed a maximum value.

16. (Original) The method of claim 15, wherein the maximum value is about 7.2 K.

17. (Original) The method of claim 13, wherein ramp-up is primarily current-limited during the first phase of ramp-up and magnetic field strength-limited during the second phase of the ramp-up, and wherein a switching parameter value defines a transition point between the first phase and second phase.

18. (Original) The method of claim 17, wherein the target frequency is approximately 15.0002 MHz or the target magnetic field strength is approximately 0.35 Tesla.

19. (Original) The method of claim 17, wherein the switching parameter value is in the range of 35-40 amperes of magnet current.

20. (Original) The method of claim 17, wherein power is applied at an initial level of approximately 2.2 volts at approximately 15 amperes for the first phase of ramp-up.

21. (Original) The method of claim 17, wherein power is applied during the first phase of ramp-up at a generally constant voltage and a generally constant current.

22. (Original) The method of claim 13, wherein transition from the first phase to the second phase occurs automatically without operator intervention.

23. (Original) A system for automatically ramping a superconducting magnet, comprising:

an autoramp controller coupled to a power supply and configured to control a automatic ramp of the magnet;

the power supply coupled via charge lines to the magnet for supplying current to the magnet;

the power supply coupled via sense lines to the magnet for measuring magnet current;

one or more magnet temperature sensors coupled via an analog-to-digital converter to the autoramp controller for measuring magnet temperature; and

a magnet field strength or frequency sensor coupled via a meter to the autoramp controller for measuring magnet field strength or frequency.

24. (Original) The system of claim 23, wherein the autoramp controller is coupled via sense lines to transducers disposed at terminals on the magnet to measure magnet current.

25. (Original) The system of claim 23, wherein the meter for measuring magnet field strength or frequency is a Tesla meter, and the magnet field strength or frequency sensor is a Tesla meter probe inserted into the magnet bore.

26. (Original) The system of claim 23, comprising:

a general purpose interface bus (GPIB) configured to receive digital signals from the analog-to-digital converter for the magnet temperature sensors and from the meter for the magnet field strength or frequency sensor; and

wherein the GPIB provides the digital signals to the autoramp controller.

27. (Original) The system of claim 26, wherein the autoramp controller comprises a general purpose computer or a laptop computer.

28. (Original) A superconducting magnet system, comprising:

one or more magnets;

a cryogen vessel disposed in the superconducting magnet system and holding a cryogen for cooling the one or more magnets;

an autoramp controller coupled to a power supply and configured to control a automatic ramp of the magnet;

the power supply connected via charge lines to the magnet for providing current to the magnet;

the power supply connected via sense lines to the magnet for reading magnet current;

one or more magnet temperature sensors for measuring magnet temperature coupled via an analog-to-digital converter to the autoramp controller;

a magnet field strength or frequency sensor for measuring magnet field strength or frequency coupled via a meter to the autoramp controller.

29. (Original) The system of claim 28, wherein the meter for measuring magnet field strength or frequency is a Tesla meter, and the magnet field strength or frequency sensor is a Tesla meter probe inserted into the magnet bore.

30. (Original) The system of claim 28, comprising:

a general purpose interface bus (GPIB) configured to receive digital signals from the analog-to-digital converter for the magnet temperature sensors and from the meter for the magnet field strength or frequency sensor; and

wherein the GPIB provides the digital signals to the autoramp controller.

31. (Original) The system of claim 28, comprising:

a cold head configured for removing heat from the superconducting magnet and condensing cryogen vapor received from a vapor space of the cryogen vessel;

a refrigerant compressor system that supplies refrigerant to the cold head to cool the cold head;

a heater for vaporizing cryogen liquid and controlling pressure in the cryogen vessel; and

a relief vent disposed in the superconducting magnet system for relieving cryogen from the cryogen vessel;

32. (Original) The system of claim 31, wherein the superconducting magnet system is disposed within a magnetic resonance (MR) imaging system.

33. (Original) The system of claim 31, wherein the cryogen comprises helium.

34. (Original) A system for automatically controlling ramp-up of a superconducting magnet, comprising:

means for connecting a power supply to the magnet;

means for determining constraining parameters of the ramp-up;

means for applying power to the magnet;

means for automatically controlling the ramp-up based on the constraining parameters; and

means for continuing ramp-up until a predetermined value of a target parameter is reached.

35. (Original) The system of claim 34, comprising means for automatically controlling a rate of supply current to the magnet based on the constraining parameters, and wherein the target parameter comprises magnet frequency or field strength, and the constraining parameters include magnet current and magnet temperature.

36. (Original) The system of claim 35, comprising:

means for measuring operating values of the constraining parameters; and

means for comparing the operating values with set points of the constraining parameters to control the rate of supply current.

37. (Original) The system of claim 35, comprising:

means for measuring magnet temperature, current applied to the magnet, and magnet field strength continuously during the ramp-up process.

38. (Original) The system of claim 37 wherein constraining parameters comprise magnet current and temperature during a first phase of the ramp-up and comprise magnet frequency or field strength and temperature during a second phase of the ramp-up.

39 (Original) The system of claim 37, wherein constraining parameters during the first phase and second phase comprise magnet temperature.

40. (Original) The system of claim 39, wherein magnet temperature comprises magnet coil temperature, cryogen temperature, or radiation shield temperature, such magnet temperature controlled to remain less than about 7 K, and a total increase in magnet temperature over the ramp-up is controlled to remain at less than about 2 K.

41. (Original) The system of claim 39, comprising means for controlling the rate of supply current in the range of 0 to 4 amperes per minute.

42. (Original) The system of claim 38, wherein a switching point specifies when constraining parameters change between the first phase and second phase.

43. (Original) The system of claim 42, wherein the switching point is reached when a field strength of the magnet system becomes stable.

44. (Original) The system of claim 42, wherein the switching point comprises a magnet current in the range of 35-40 amperes.

45. (Original) The system of claim 35, wherein the predetermined value of the target parameter is a magnet frequency of about 15.0002 megahertz.

46. (Original) A system for automatically controlling a ramp-up of a superconducting magnet, comprising:

means for applying power to the magnet constrained by a target current ramp-up rate and magnet temperature during a first phase of ramp-up;

means for applying power to the magnet constrained by a target magnetic field strength or frequency and by magnet temperature during a second phase of ramp-up; and

means for terminating application of power to the magnet upon reaching a target magnetic field strength or frequency.

47. (Original) The system of claim 46, comprising means for measuring magnet temperature, current applied to the magnet, and magnetic field strength continuously during ramp-up.

48. (Original) The system of claim 46, comprising means for automatically controlling ramp-up such that the magnet temperature does not exceed a maximum value.

49. (Original) The system of claim 48, wherein the maximum value is about 7.2 K.

50. (Original) The system of claim 46, wherein ramp-up is primarily current-limited during the first phase of ramp-up and magnetic field strength-limited during the second phase of the ramp-up, and wherein a switching parameter value defines a transition point between the first phase and second phase.

51. (Original) The system of claim 50, wherein the target frequency is approximately 15.0002 MHz or the target magnetic field strength is approximately 0.35 Tesla.

52. (Original) The system of claim 50, wherein the switching parameter value is in the range of 35-40 amperes of magnet current.

53. (Original) The system of claim 50, wherein power is applied at an initial level of approximately 2.2 volts at approximately 15 amperes for the first phase of ramp-up.

54. (Original) The system of claim 50, wherein power is applied during the first phase of ramp-up at a generally constant voltage and a generally constant current.

55. (Original) The system of claim 46, wherein transition from the first phase to the second phase occurs automatically without operator intervention.

Claims 56-77. (Cancelled)